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China's Technology Transfer Strategy: A Long-Term, Systematic Threat to the US & NASA



F-35 (United States)



J-31 (China)

This Counterintelligence Executive Brief was prepared by Special Agent George Crawford, NASA Glenn Research Center (GRC) CI/CT Office. This product outlines China's highly robust technology transfer strategy that involves the use of multiple licit and illicit vehicles to obtain technology from the US and other countries and how the US and NASA are extremely vulnerable to targeting under this strategy.

EXECUTIVE SUMMARY

China's Technology Transfer via Early Stage Investments & Acquisition

China is executing a multi-decade plan to transfer technology to China to increase the size and value-add of its economy, currently the world's 2nd largest. By 2050, China may be 150% the size of the US and decrease US relevance globally. Chinese participation in venture-backed startups is at a record level of 10-16% of all venture deals (2015-2017) and has grown quite rapidly in the past seven years.



China has developed a leading global economy faster than any country in modern history. This transformation began with the reform and opening of China's economy under Deng Xiaoping in 1978. By 2015, China's GDP was \$11.4 trillion compared to the US at \$18 trillion. However, in purchasing power parity (PPP), China is already slightly larger than the US. This represents the first time the US has not been the largest economy since it overtook the United Kingdom in 1872. Since the US economy is growing at 1-3% and China's is growing at 5-7%, the trajectory is clear in narrowing the GDP gap (some projections show China's GDP exceeding US GDP within the next decade). The time scale during which this growth occurred is stunning as China's economy has grown from 10% of the US economy in the 1970s to the second largest global economy in just fifty years. Analogous growth in the US economy to global leadership took a century to achieve.

Two important trends stand out with the new wave of technology being funded: First, the line demarcating products designed and used for commercial versus military purposes is blurring with these emerging technologies. Second, these technologies – from artificial intelligence to robotics and virtual reality – will be foundational so that many applications or end-use technologies will be built upon them.

Technology transfer to China occurs in part through increasing levels of investment and acquisitions of US companies. China is investing in the critical future technologies that will be foundational for future innovations both for commercial and military applications: artificial intelligence, robotics, autonomous vehicles, augmented and virtual reality, financial technology and gene editing. In 2015, Chinese investment in this portfolio of technologies represented approximately 20% of their overall investment, rising to 40% in 2016 and at 29% through the first three quarters of 2017. The line demarcating products designed for commercial vs military purposes is blurring with these new technologies.

- ❖ China's global foreign direct investment (FDI) is growing rapidly and is at a record level in a range of \$200-250 billion, with \$213 billion in announced acquisitions in 2016.^{8,9} China's FDI investment in the US in 2016 was \$45.6 billion and cumulative FDI in the US since 2000 now exceeds \$100 billion.
- ❖ China's total investment in US technology (electronics, information and communications technology, biotech and energy) for the past decade, 2006-2016, totaled \$35 billion and in 2016 was about \$8.5B. Since the US is a global leader of technological innovation, it is logical that China would seek to make increasing investments in US technology companies.

Chinese acquisitions continue to increase dramatically with the largest globally being China National Chemical Corporation's proposed takeover of Syngenta (Swiss pesticides) for \$43 billion. China's acquisitions of foreign companies are now equal to US firms' acquisitions of foreign companies. In the US, the largest recent China-based acquisitions have been the electronics distributor, Ingram Micro (\$6.1 billion) and the U.S. hotel owner, Strategic Hotels & Resorts – owners of the Waldorf-Astoria Hotel (\$8.1 billion).

Other Sources & Methods of China's Technology Transfer

Eight principal sources and methods for technology transfer in addition to investments and acquisitions include:

- ❖ Industrial espionage, where China is by far the most aggressive country operating in the US.
- ❖ Cyber theft on a massive scale deploying hundreds of thousands of Chinese army professionals. According to the 2013 IP Commission Report, Verizon worked with 18 private institutions and government agencies to estimate that: 96% of the world's cyber espionage originated in China; \$100 billion in lost sales and 2.1 million in lost jobs result from this theft; and \$300 billion worth of intellectual property is stolen each year.
- ❖ Academia, since 25% of US STEM graduate students are Chinese foreign nationals. Statistics on US STEM programs highlight the large proportion of foreign students: 84% of foreign students in PhD programs were studying in science and engineering (2001-2011); for doctoral programs, 57% of engineering, 53% of computer science and 50% of math and statistics candidates were foreign and half of these were Chinese; 54% of patents issued by universities include foreign student's work; and 45% of STEM undergraduates are foreign and one third of these are from China.
- ❖ China's use of open source information cataloguing foreign innovation on a large scale.
- ❖ Chinese-based technology transfer organizations.
- ❖ US-based associations sponsored by the Chinese government to recruit talent.
- ❖ Leveraging technical expertise learned from US private equity, venture firms, investment banks and law firms.

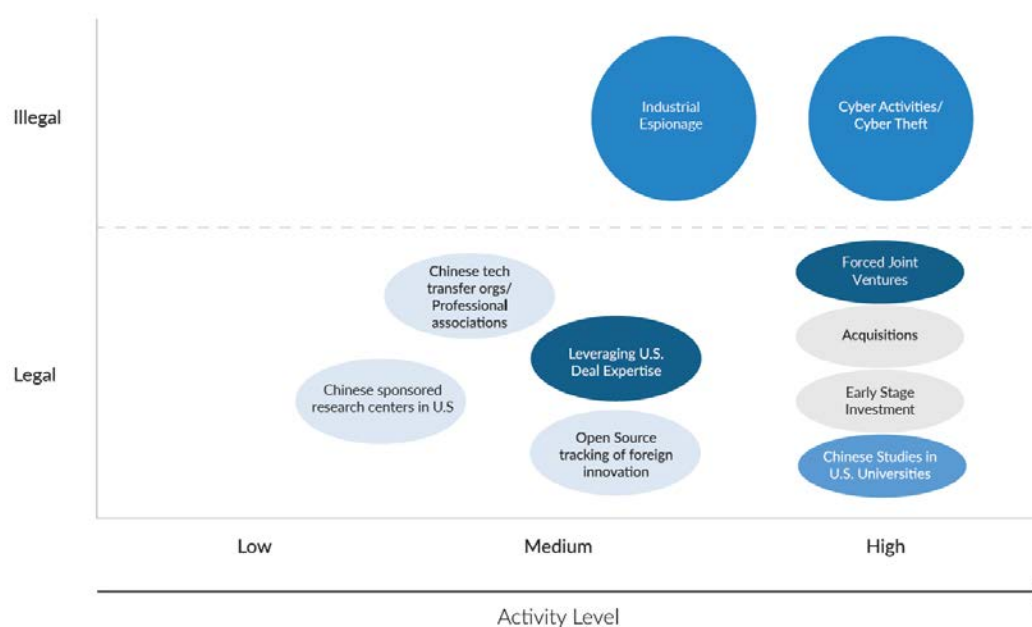


Figure 1: China's Sources & Methods of Technology Transfer

China's Technology Goals & Plans

China's goals are to be #1 in global market share in key industries, to reduce reliance on foreign technology and to foster indigenous innovation. The growing investments in US technology overall, and early-stage ventures in particular, comprise a part of China's plan to acquire expertise from abroad and to develop indigenous innovation.

These investments are consistent with China's goals made clear in President Xi Jinping's statements, successive Five Year Plans, Made in China 2025 and Project 863 to: (1) Establish China as one of the most innovative countries by 2020 and a leading innovator by 2030; (2) become a leading global science and technology power by 2049 -- the 100th anniversary of the PRC; and (3) double down on R&D of core

information and communications (ICT) technologies...to develop technologies on its own, acquiring expertise from abroad when indigenous development is not possible. Explanations of some of the plans are as follows:

- ❖ **Made in China 2025** is a plan designed to align State and private efforts to establish China as the world's pre-eminent manufacturing power by 2049 emphasizing the integration of information technology. Key prioritized sectors include advanced information technology, automated machine tools and robotics, aerospace and aeronautical equipment, maritime equipment and high tech shipping and biopharma and advanced medical products.
- ❖ **13th Five Year Plan of 2016-2020 "Internet Plus"** is a plan that deepens reforms and priorities called for in Made in China 2025 and emphasizes stronger control by the government over national networks as China continues to control the internet domestically and gains access to global networks by controlling key component and telecommunications technologies. This plan focuses on catapulting China into a leading position in "advanced industries" including semiconductors, chip materials, robotics, aviation equipment and satellites.
- ❖ **China's Mega Project Priorities** are 16 Manhattan-style projects to focus on specific innovations. In China these projects receive a national (not just a military) focus. Here are some selected examples: Core electronics, high-end general chips, basic software; next generation broadband wireless mobile communications; quantum communications; and classified defense-related projects (possibly satellite navigation and inertial confinement fusion).
- ❖ **China's Thousand Talents Program** started in 2008. It aims to recruit Chinese experts globally from businesses, industry, and universities with multiple incentives to lure back scientists who have trained abroad. The program is a vital part of Chinese industry. In recent years, a particular emphasis has been placed on early-career scientists, and nearly 3,000 "young talents" have been supported. As more promising young Chinese scientists elect to start their laboratories back home — instead of in the US — the next generation of insights and innovations will increasingly emerge from China.

China's Innovation

By some measures of innovation, China is already leading and China's capacity to innovate is rising:

- ❖ In patent applications, China already surpasses the US with over 1 million patent applications received by the China State Intellectual Property Office in 2015 (up 19% year over year) compared to 589,410 patent applications received by the US Patent and Trademark Office (up 2% year over year).
- ❖ In academic research papers, Chinese authorship of articles in peer-reviewed international science journals increased such that China is now in 2nd place (2011) up from 13th place just a few years earlier.
- ❖ China spent 1.6% of GDP in R&D in 2011, but has a stated goal of spending 2.5% of GDP R&D by 2020 – about \$350 billion. Combined US business and federal government R&D spending is 3-4% of GDP.
- ❖ China awarded 1,288,999 Science, Technology, Engineering & Mathematics (STEM) degrees in 2014 – more than double the degrees the US awarded at 525,374 degrees.

Impact of Chinese Technology Transfer on the US

According to Defense Innovation Unit Experimental (DIUx) study on China's Technology Transfer Strategy, January 2018, the US does not have a comprehensive policy or the tools to address this massive technology transfer to China and the US government does not have a holistic view of how fast this technology transfer is occurring, the level of Chinese investment in US technology, or what technologies should be protected.

China's goal to be the preeminent global economy combined with its emphasis on technology transfer and innovation constitutes a major strategic competition with the US. There are several implications for the US Department of Defense:

- ❖ China's transformation to be the manufacturer for the world means more supply chains are owned by China, which creates risks to US military technology and operations. For example, the Aviation Industry Corporation of China (AVIC) is a Chinese-state owned aerospace and defense company which has now procured key components of the US military aircraft supply chain. Additionally, as the US-based semiconductor industry focuses on high-end designs and moves older, low-end designs offshore, the Chinese semiconductor industry now controls a significant percentage of the supply of older chips used in maintaining US military aircraft and equipment designed 40 years ago and still in service. AVIC previously requested to visit NASA to discuss possible collaboration in fundamental research in aerodynamics like civil aircraft testing and design of wind tunnels for civil applications. AVIC is also currently working on hypersonic technologies. AVIC, as early as 1986, tasked Greg Chung to collect on US "advanced technologies" for money and to travel to China for meetings using cover stories. Greg Chung, a retired Rockwell International and Boeing engineer, spied for China for almost 30 years on the US Space Shuttle, military aircraft and Delta IV rocket.
- ❖ China has targeted several key technologies such as jet engine design which will reduce current US military superiority and is actively working to acquire companies that will close this gap.
- ❖ China's industrial espionage and cyber theft efforts continue without adequate US investment in manpower and programs to thwart these efforts. This allows technology transfer at an alarming rate.
- ❖ China's investment strategy (through venture and private equity investments as well as acquisitions) includes the fundamental technologies which will likely be the sources of innovation for the next several decades: artificial intelligence, autonomous vehicles, robotics, augmented and virtual reality, gene editing, etc. As a result, China has access to US-based innovation in the same areas and at the same time which could negate advantages for the US
- ❖ Beyond the threat from investments alone, China's national focus on mega projects (analogous to the US space program in the 1960s to not only develop technology but create demand for technology) complements the increase in military spending as China gains experience in manufacturing and refining new technologies for practical use.

The DIUx study also mentions if China continues to maintain the same level of access to US technology, the US may lose technological superiority and it may facilitate Chinese technological superiority.

NASA COUNTERINTELLIGENCE PERSPECTIVE

China's technology transfer strategy is highly robust and involves use of multiple licit and illicit vehicles from investment to acquisition to industrial espionage to cyber theft. China's aggressive technology transfer efforts and stated plans and goals, prove it is determined to continue its extensive efforts long-term, systematic efforts to be #1 in global market share in key industries, to reduce reliance on foreign technology and to foster indigenous innovation. The US and NASA are extremely vulnerable to targeting by China via China's sources and methods of technology transfer.

Collaborative efforts between NASA, US/foreign universities and domestic/foreign companies are essential to the advancement of technology. However, adversaries such as China have identified these collaborative efforts as a significant opportunity to steal information and technology in a highly systematic way and recruit talent. NASA civil servants and contractors should have an understanding of China's technology transfer sources, methods, plans and goals and how their interactions with Chinese nationals and organizations fit in China's overall strategy. They should also understand how this long-term, systematic strategy could have a significant impact on US economic and national security.

The recent arrest of Yanjun Xu serves as one example Chinese targeting. Xu, a Chinese Ministry of State Security (MSS) operative, was arrested for conspiring and attempting to commit economic espionage and steal trade secrets from multiple US aviation and aerospace companies. Based on recent NASA employee reporting, NASA CI has observed the phenomenon where China is much more frequently and aggressively targeting NASA employees for China travel, including subsidized trips. The number of unsolicited emails directed at NASA employees from Chinese IP addresses has increased significantly over the past two years. Not only are these emails emblematic of foreign interest in an employee's research, they frequently offer an attractive invitation for an employee's attendance and presentation at an event in China. Offers for employee "presentations" in China have ranged from partial to all-expenses-paid travel. China and other high threat countries are known to exploit the scientific culture of openness at conferences, symposia and academia to identify, assess, and potentially recruit US experts.

NASA civil servants or contractors with any information concerning suspected or actual spotting and assessing of NASA researchers and scientists for possible recruitment by foreign intelligence services, receipt of unsolicited email requesting NASA SBU/sensitive information, and/or invitations or offers of subsidized travel to attend and present in high threat countries should immediately report this information to their servicing NASA CI office. In addition, NASA civil servants and contractors hosting or escorting foreign nationals from countries on NASA's "Designated Countries" List and/or Russia are required to receive face-to-face (F2F) foreign visit briefings/debriefings from their servicing NASA CI Office. Visits also include meetings that are held outside NASA-controlled facilities.

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DISTRIBUTION: NASA Civil Servants & Contractors

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